FormFactor®
The MicroSpring® Company

Optimization of MicroSpring® Contact Design Parameters for Low Pressure Probing

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Southwest Test Workshop 2004

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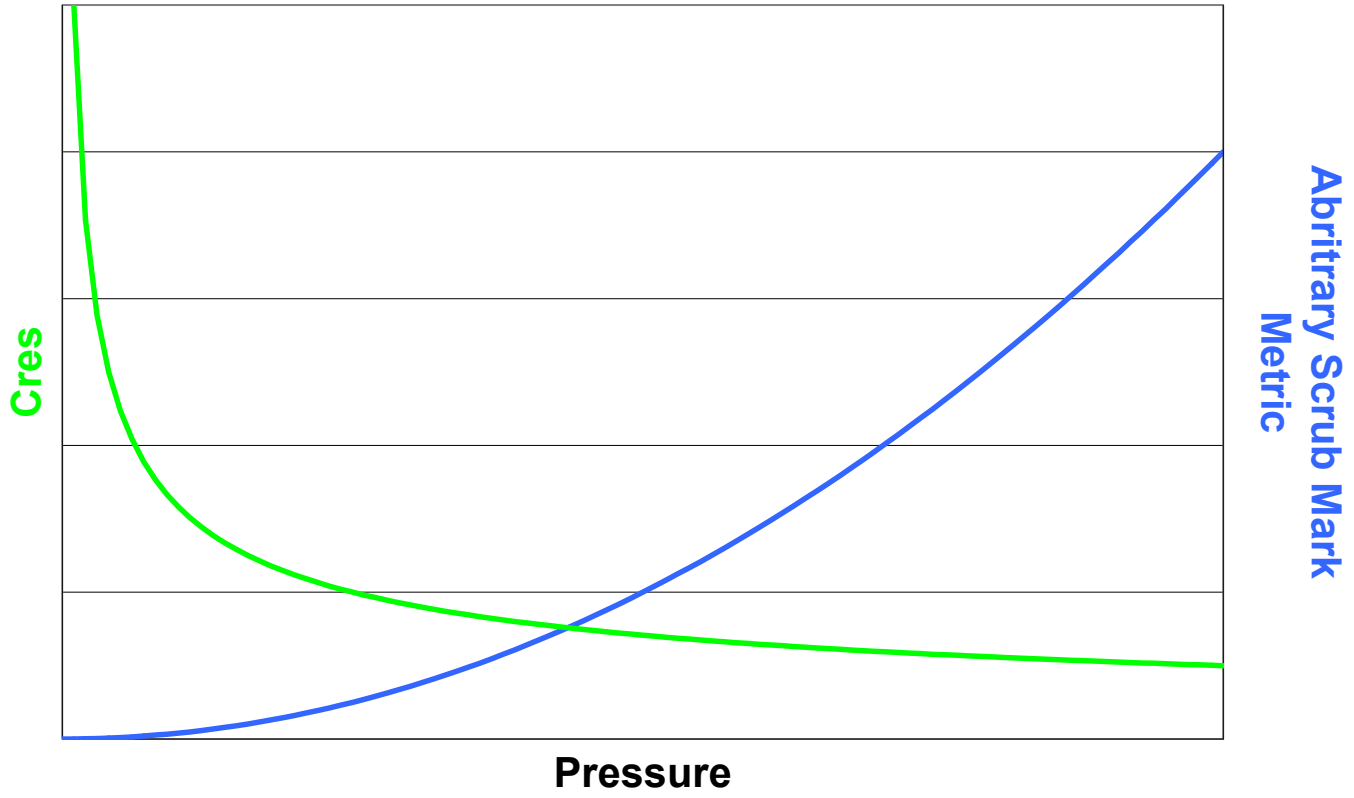
Industry Trends

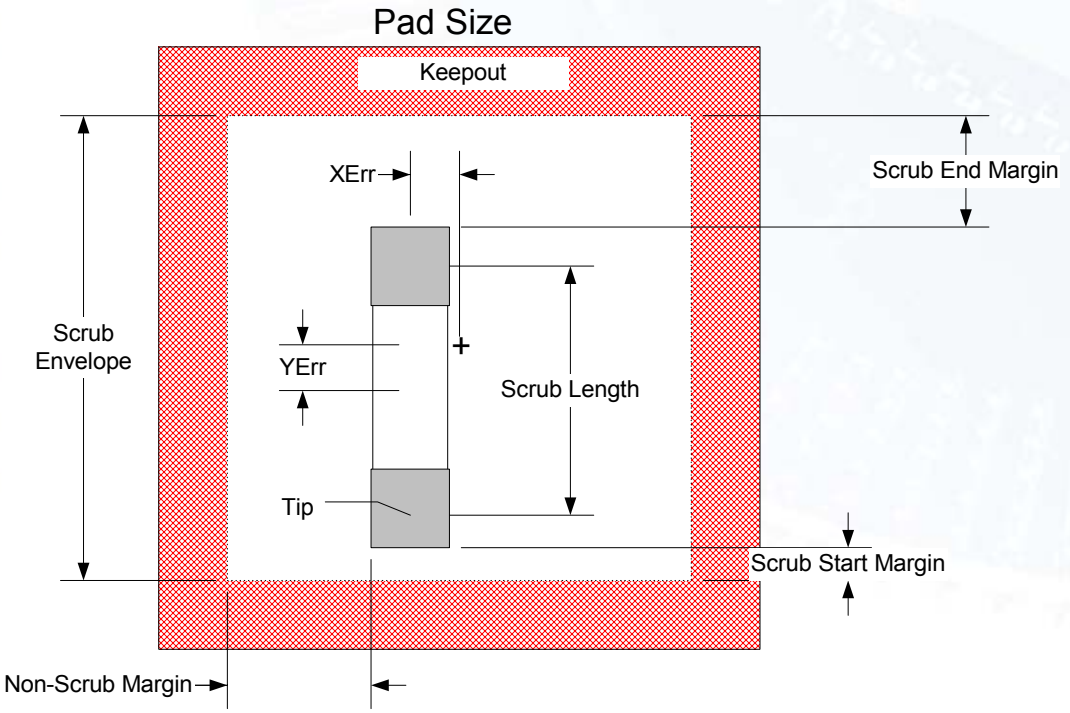
- New Bond Pad Stackups
  - Copper metallization
  - Low K dielectric
  - Probing over active area
- Lower Power Devices, driven by mobile products, reduce test margins

Probing Operating Space
Cres Vs. Pressure



- Pressure is an independent variable that modulates both Cres and the scrub mark metric.
- Must balance two opposing requirements

Probing Operating Space
Scrub Mark Metrics

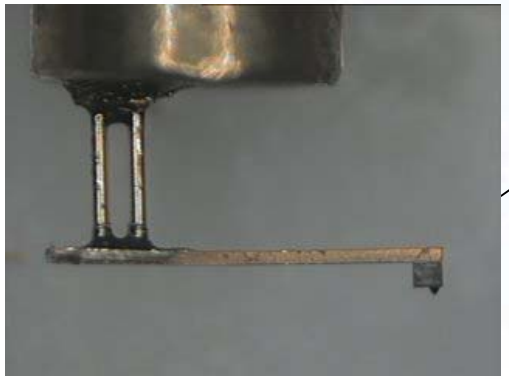


- Length
- Width
- Depth
  - Expose lower stack metals
  - Package reliability issues
- Size/Location
  - Hit passivation
- # of TD's
  - Multiple sorts common
  - Double touch recipes common

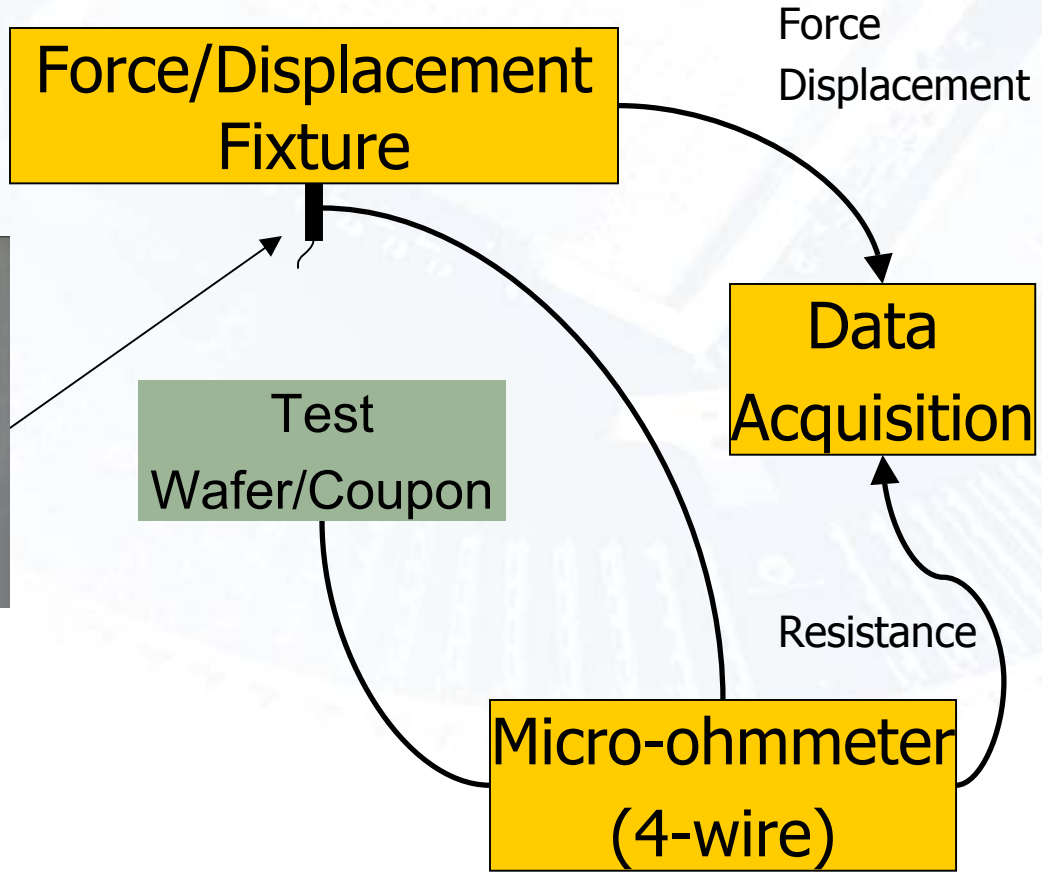
Case Study
New Bond Pad Stack-up Metallization

- Requirements:
  - No exposure of base metal after repeated touchdowns
    - Thin Al over base metal
  - Low, stable Cres
- Approach:
  - Predictive Probing at FFI
    - Scrub Characterization
    - Cres
  - Customer Site Validation
    - Scrub Characterization
    - Qualification

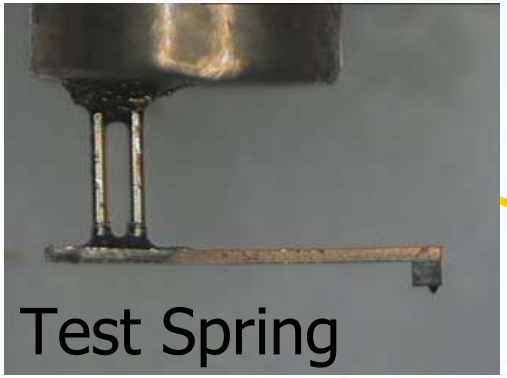
Experimental Setup
Predictive Probing at FormFactor

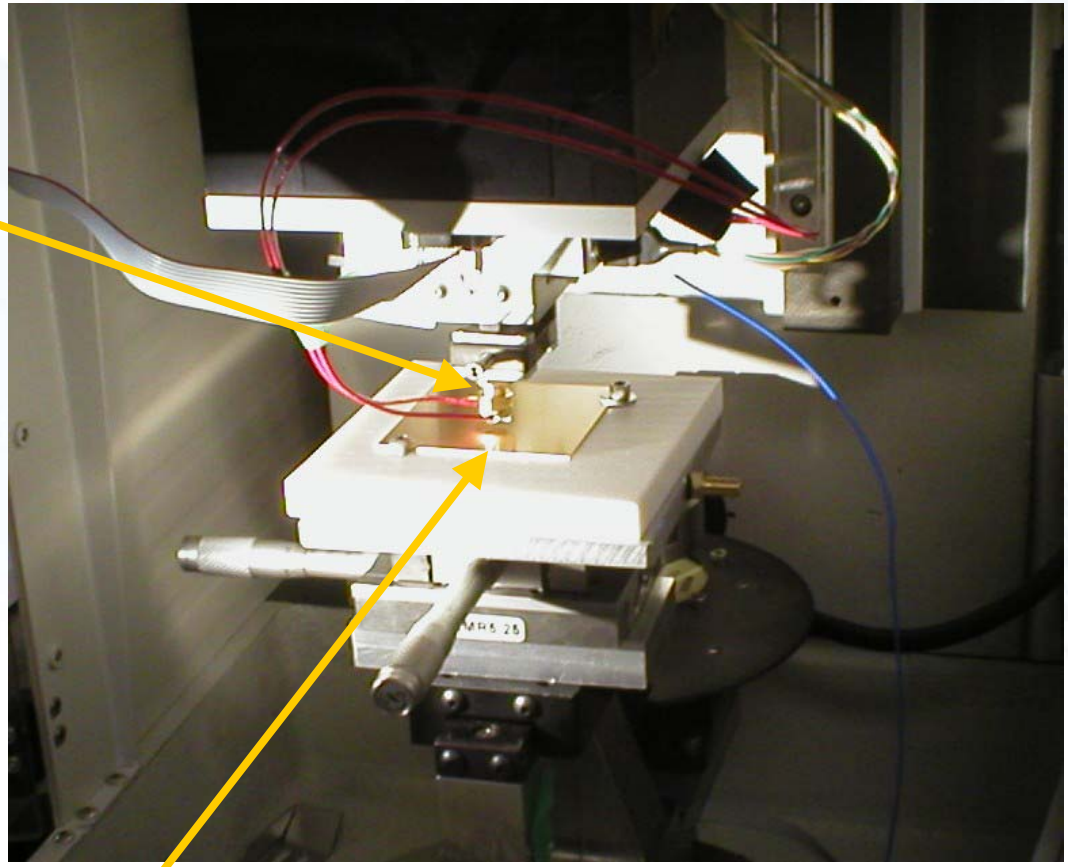


Test Spring



Experimental Setup
Predictive Probing at FormFactor

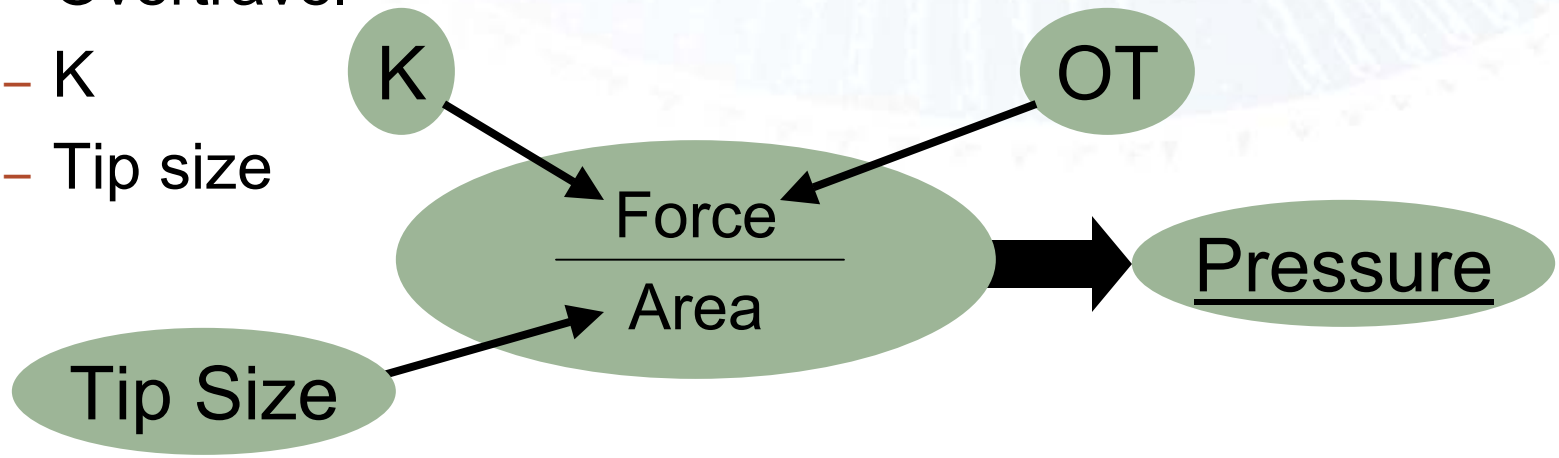




Au plated Cres Test Coupon shown

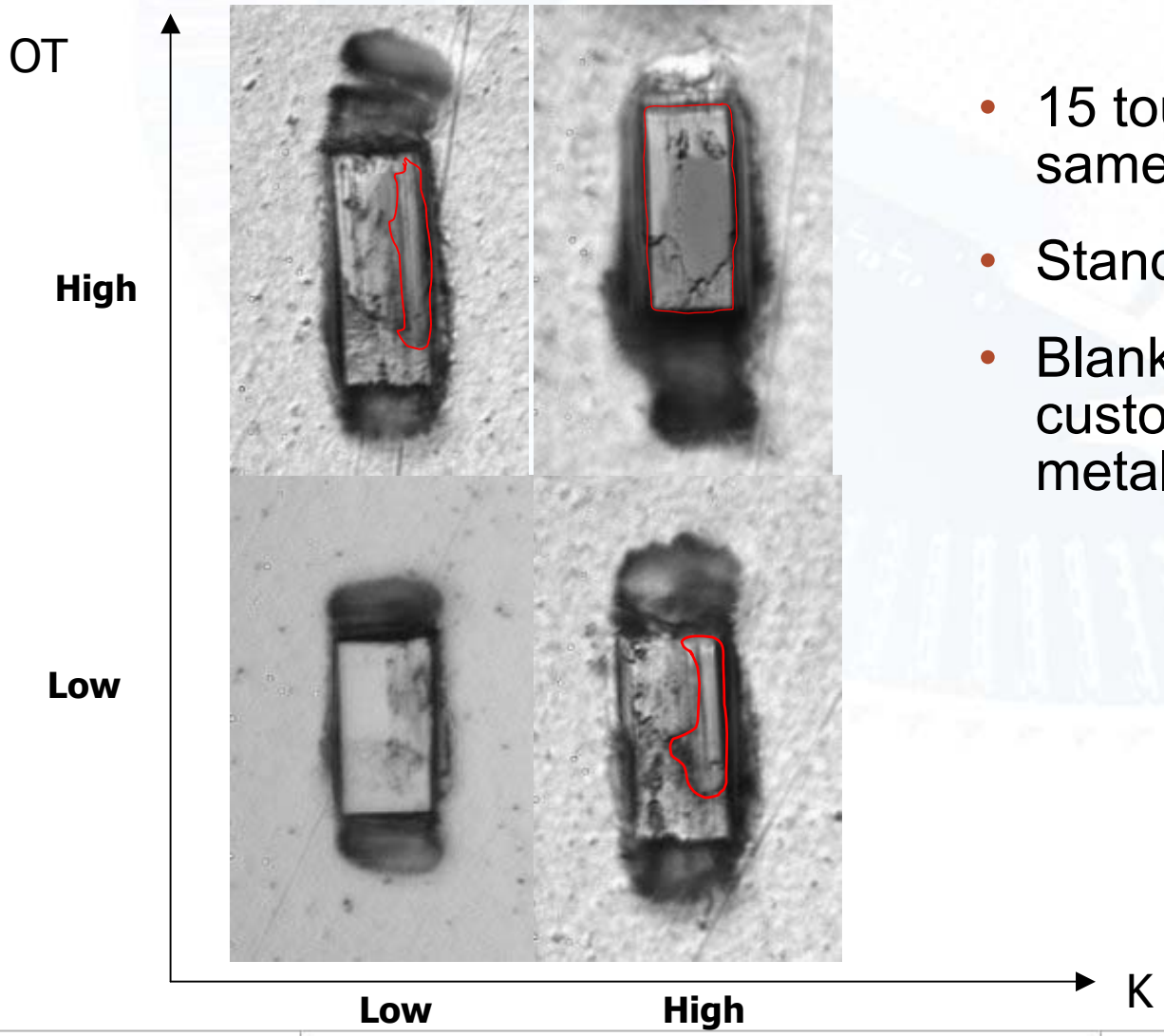
Predictive Probing Evaluation of Pressure Parameters

- Pressure is a first order variable for both Scrub mark and Cres.
  - Pressure=Applied Force/Contact Area
- FFI design parameters and probing recipes can be optimized to control pressure for specific applications.
  - Overtravel
  - K
  - Tip size



Predictive Probing Pressure Evaluation

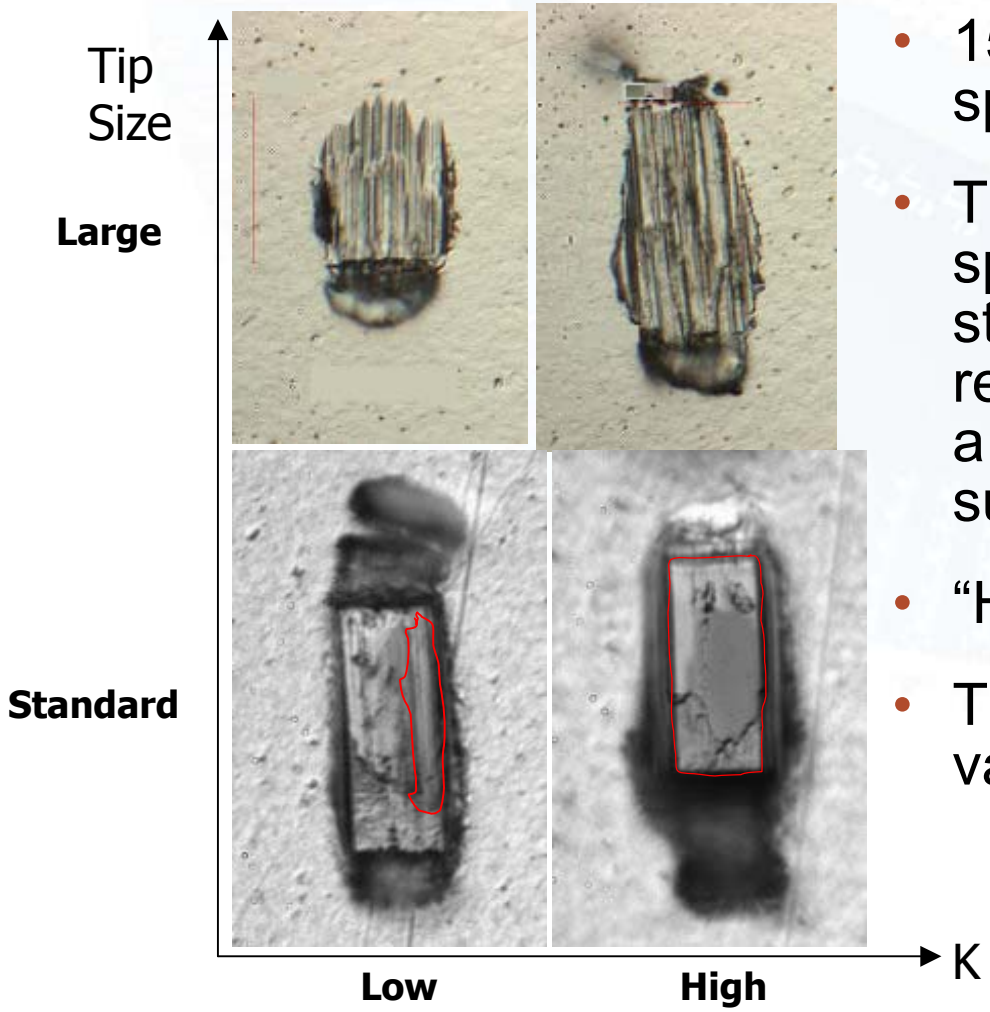
Effects of K and Overtravel



- 15 touchdowns in same spot
- Standard tip size
- Blanket wafer with customer metallurgy/stack

Predictive Probing Pressure Evaluation

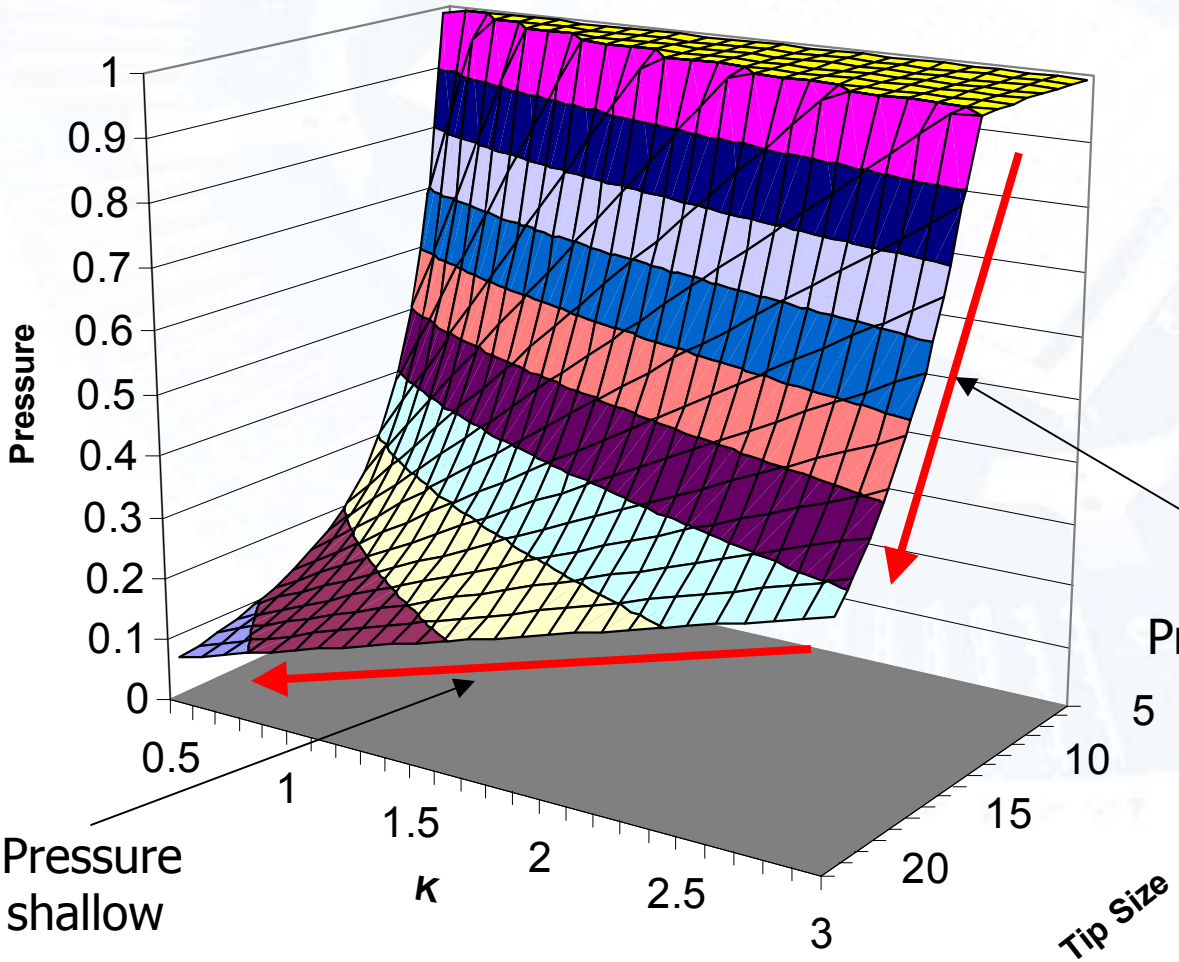
Effects of K and Tip Size



- 15 touchdowns in same spot
- The low and high g/mil springs were grown from standard to large by repeated touchdowns on a controlled abrasive surface
- “High” OT for all cases.
- Tip size is dominant variable.

Pressure Surface Relationship

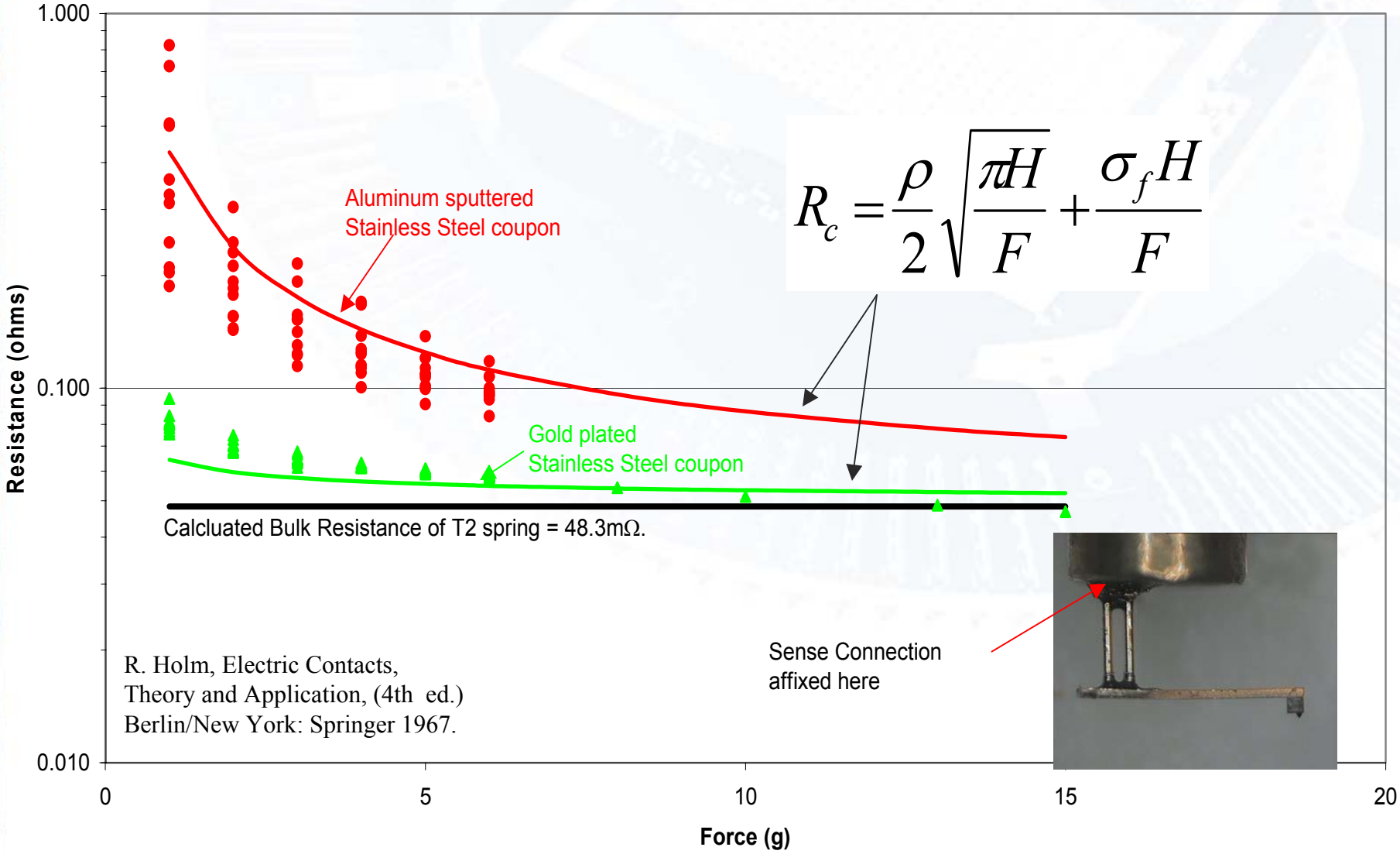
For Constant Overtravel



Increasing tip size is most effective in reducing pressure.

Predictive Probing Cres Evaluation

Au and Al Coated Substrates



Predictive Probing Cres Evaluation

Force vs. Resistance – Holm Theory

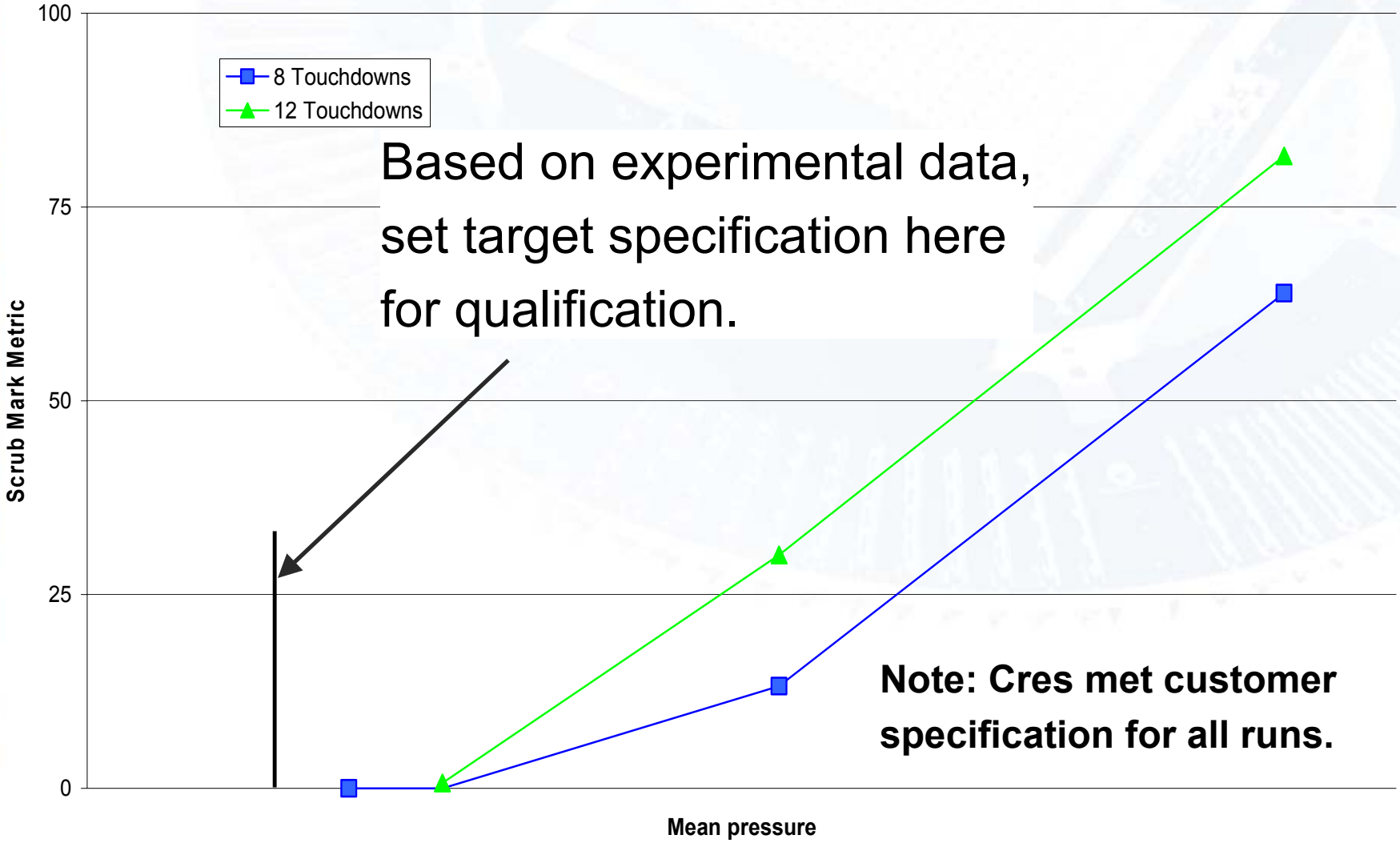
$$R_c = \frac{\rho}{2}\sqrt{\frac{\pi H}{F}} + \frac{\sigma_f H}{F}$$

- Aluminum Material Properties (from MatWeb):
  - H_{al}= 15 Kg/mm^2
  - ρ_{al}= 2.7E-6 Ω-cm
  - σ_f is unknown.
- Since all other variables are known, the film resistivity for the Aluminum case can be estimated from the experimental data.
  - σ_f ~ 2.5E-7 Ω-cm^2
  - Establishing this material parameter allows for more accurate estimates of Cres for future applications.

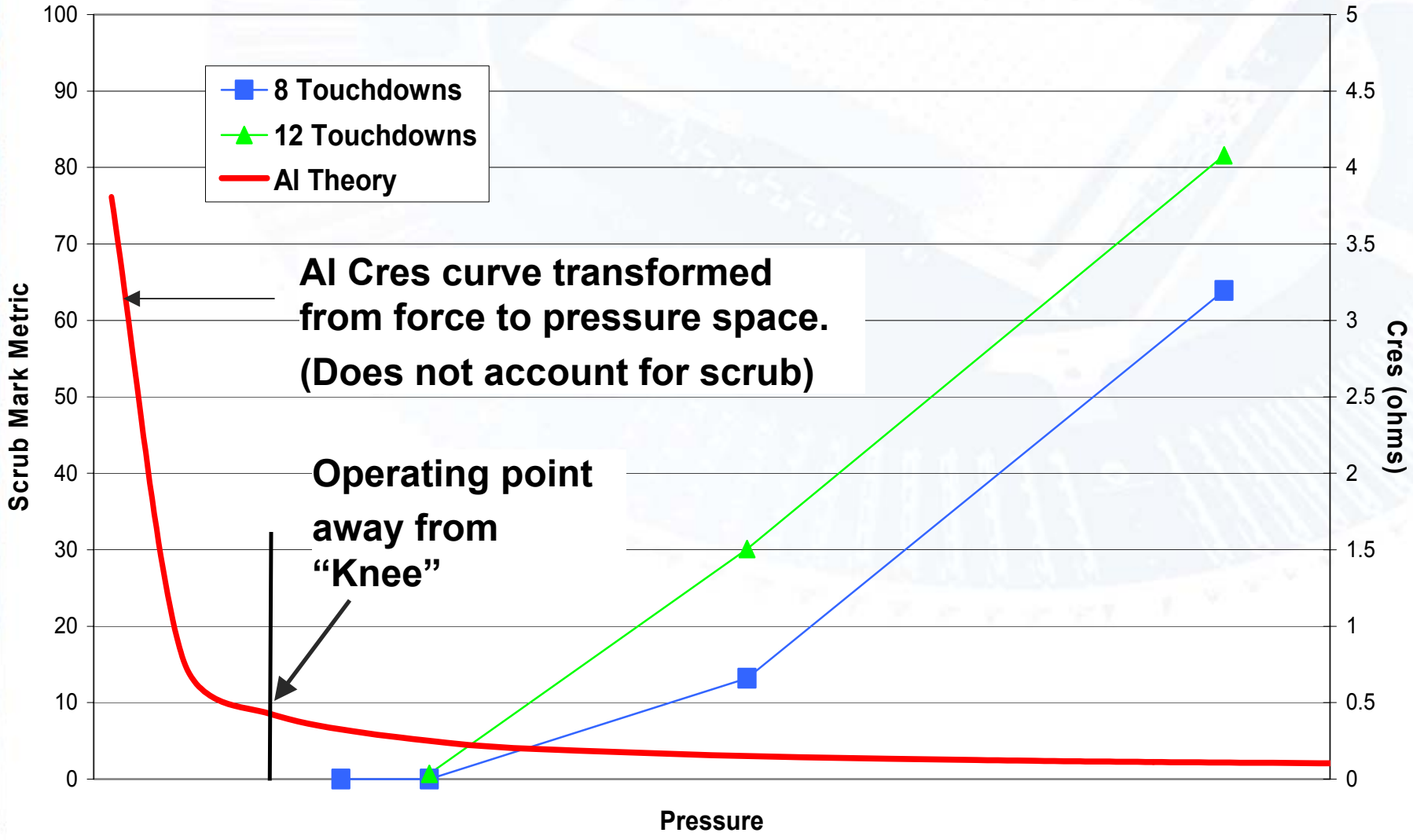
Predictive Probing Summary
Customer Site Evaluation

- Predictive Probing Summary
  - Evaluated significant parameters for scrub mark
    - Design parameters selected for field evaluation
  - Characterized Cres to high resolution
- Customer evaluation
  - Several cards were evaluated at customer site
    - Varied K, tip size and number of touchdowns
    - Probed test wafers with production metal stack
    - Cres monitored for all tests
  - Objectives:
    - Define design parameters for qualification
    - Define probing recipe for qualification

Field Characterization



Cres/Scrub Mark Metric Vs. Pressure



Product Qualified

- All Qualification testing passed
  - Lifetime Test
  - ILD damage
  - Scrub Cpk
  - Multiple TD analysis
  - Package reliability

Conclusion

- FormFactor's MicroSpring Contact probing solution allows for customization for specific applications
  - Overtravel
  - K
  - Tip size
- Predictive Probing enables FFI to simulate customer environments
  - Validated at multiple customers and applications

Acknowledgments

- Intel
  - Trung Nguyen, Mike Dang, Reuben Gallegos
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  - Fred Lane, Eric Watje